

**Statement of Robert Shane Johnson
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Before the
Subcommittee on Energy and Resources
Committee on Government Reform
U.S. House of Representatives
June 29, 2005**

Chairman Issa, Ranking Member Watson and distinguished members of the Subcommittee, I am Shane Johnson, Acting Director of DOE's Office of Nuclear Energy, Science and Technology and Deputy Director for Technology. I appreciate the opportunity to provide this testimony for the record on the Department of Energy's efforts to develop advanced reactor technologies for our Nation's secure and reliable future energy supply.

The President's National Energy Policy recommends expanded use of nuclear energy to reduce dependence on imported fuels and to reduce harmful air emissions. To achieve this vision, the Secretary of Energy unveiled the *Nuclear Power 2010* initiative in February 2002 with the program aimed at encouraging licensing, construction and operation of new nuclear plants in the United States within the decade. As a result of the hard work of industry in creating a solid foundation for new plant orders and the partnership between DOE and industry to address potential barriers to new nuclear plant construction, the Department believes that the country will see new plant orders placed in this decade.

In 2001, the Department launched the *Generation IV* nuclear energy systems initiative to begin investigating advanced reactor and fuel cycle technologies – technologies that could become available for commercial deployment between the 2020 and 2030 timeframe and offer significant advances in proliferation resistance, reduced waste intensity, improved physical security, safety, and sustainability over today's Generation III reactors, which were developed more recently in the 1990's and 2000's. The primary focus of these advanced systems would be to generate electricity in a safe, economic and secure manner; other possible benefits include the production of hydrogen, desalinated water, and process heat.

While the Generation IV initiative started in the United States, the initiative has become an international initiative. In 2001, the Department led the formation of the *Generation IV International Forum* (GIF), an international collective of leading nuclear nations committed to working together to develop advanced technologies. Over a two-year period, more than 100 experts from the GIF member countries completed a technology roadmap that identified six promising reactor concepts that are the focus of ongoing research and development efforts among the nations; the GIF membership expanded to include one additional country and the European Union; and a landmark framework

agreement put in place this past February 2005 guides the research investments and the collaborations among the nations on these key technologies.

Additionally, the Department of Energy established a new central laboratory in February 2005 – the Idaho National Laboratory -- to lead the Government's research and development on reactor and fuel cycle development. The formation of the Idaho National Laboratory is a key step forward for the nuclear energy program, enabling the establishment of a dedicated research site at which we can build the expertise needed to develop these advanced technologies. Today, working through the Idaho National Laboratory, with other national laboratories, universities, industry and the international research community, the United States is investing about \$45 million annually on advanced research into the systems, materials, and fuels that are needed to bring Generation IV concepts to fruition.

My testimony today summarizes the efforts of the United States in developing these technologies and discusses the work that remains to be done to pave the way for the deployment of advanced reactor technologies in the United States and the world. Many nations look to the United States, the country where nuclear power began, for its leadership in key policy issues such as nonproliferation and safety, as the international research community sets the standard for future international deployment of advanced reactor and fuel cycle technologies.

GENERATION IV NUCLEAR SYSTEMS INITIATIVE

In 2001, the Department of Energy launched the *Generation IV Nuclear Energy Systems Initiative* aimed at developing advanced reactor and fuel cycle technologies that can be made available to the market by 2030. These are technologies that offer significant advances toward challenging sustainability, safety and reliability and economic goals such that technologies will be competitive in all markets.

The Department also led the formation of the *Generation IV International Forum* or GIF, an international collective of ten leading nuclear nations working in joint cooperation on advanced reactor and fuel cycle technologies on a multilateral basis to address the expansion of nuclear energy globally. With the formation of the GIF, a formal charter was signed in July 2001 by representatives of the nations of Argentina, Brazil, Canada, France, Japan, Republic of Korea, Republic of South Africa, the United Kingdom and the United States. Since then, Switzerland and the European Union's Euratom have also joined the GIF.

In 2003, the GIF completed the technology roadmap, *A Technology Roadmap for Generation IV Nuclear Energy Systems*, prepared by more than 100 technical experts from the GIF countries working together to examine promising technologies. The GIF converged on six promising reactor technologies: gas cooled fast reactor systems, lead alloy liquid metal cooled reactor systems, molten salt reactor systems, sodium liquid metal cooled reactor systems, supercritical water cooled reactor systems, and very high temperature gas reactor systems. The technology roadmap identified the research and

development necessary to advance these concepts to the point of maturity for potential commercialization by the private sector.

Since then the Generation IV effort has continued to make progress. The member-countries have organized into project groups associated with each of the six selected Generation IV systems and the member-countries are negotiating international legal agreements to enable advanced nuclear research to be conducted on a multilateral basis. This past February, after a year of negotiations, an international framework agreement for collaborative research and development among the GIF member countries was signed in Washington, D.C., by the United States and its GIF partners. This framework agreement allows the United States and its partner countries to embark on joint, cost-shared research and development of Generation IV nuclear energy systems.

This landmark agreement will further the development of advanced technologies that are widely acceptable, enable the Department to access the best expertise in the world to develop complex new technologies, and allow the United States, as well as the other member countries, to carry out our research and development programs more efficiently and effectively by leveraging resources and capabilities. As noted earlier, by coordinating United States efforts with other countries our funding will be leveraged by a factor of two to ten depending on which reactor concept is involved.

GENERATION IV REACTOR CONCEPTS

The Department is pursuing research and development on a range of Generation IV reactor technologies, including the Gas-cooled Fast Reactor, the Lead-cooled Fast Reactor, the Supercritical Water-cooled Reactor, and the Very High Temperature Reactor. Our efforts on these technologies include investigation of technical and economic challenges and risks, including waste products, and developing core and fuel designs and advanced materials for these concepts. It is expected that all of these advanced reactor technologies could be sufficiently mature for deployment between 2020 and 2030.

The Gas-Cooled Fast Reactor (GFR) is a fast spectrum reactor that has the potential to use recycled fuel in order to maximize the value of the nation's uranium resources. The GFR can also benefit future repository space requirements by burning long lived actinides. The GFR has potential as a technology to support the production of hydrogen and uses helium gas as a coolant.

The Lead-Cooled Fast Reactor (LFR) is a fast spectrum reactor that operates similarly to the GFR. Instead of helium gas, the LFR uses a liquid lead-based coolant to remove reactor heat. The LFR can operate at atmospheric pressure, simplifying the design of the primary system. Like the GFR, a key benefit of the LFR is to operate in a more fully closed fuel cycle that is geared towards maximizing the utilization of uranium resources and minimizing nuclear wastes.

The Super Critical Water Reactor (SCWR) is a highly efficient water-cooled reactor that uses conventional low enriched uranium fuel and operates at extreme pressures and temperatures when compared to traditional water-cooled reactors. This allows for a far more efficient plant, capable of generating electricity with greater than 30% more efficiency than traditional light water reactors. In addition, it represents a simpler design that reduces balance of plant systems that are presently required of Generation III reactors, resulting in improved economics. Significant research and development is needed to demonstrate the safety case for the technology, to investigate materials and structures, and to develop a plant design.

The Very High Temperature Reactor (VHTR) extends existing gas cooled reactor technologies that operate between 650 and 850 degrees Celsius to operate at or near 950 degrees Celsius. The VHTR is expected to produce electricity with greater than 50% more efficiency than light water reactors. The VHTR is expected to produce the heat necessary for efficiently producing hydrogen gas using water as the only consumable resource. The VHTR maintains passive safety characteristics and has enhanced safeguards and security features.

In addition to producing electricity, all four of these Generation IV reactor concepts have the potential to provide hydrogen production without releasing greenhouse gases; current hydrogen production process primarily rely on steam reforming of methane. Nuclear generated hydrogen could introduce hydrogen into the nation's transportation infrastructure and help provide for our Nation's energy security. The Generation IV program provides support to the Nuclear Hydrogen Initiative (NHI) which serves as the focal point for conducting research and development on nuclear-based hydrogen production technologies.

While we are monitoring the progress of the international research community on the other two Generation IV concepts -- Sodium Cooled Fast Reactors and the Molten Salt Cooled Reactors -- the United States is not presently investing to any large extent in the development of these technologies. The United States has extensive experience with sodium cooled fast reactors, having operated an engineering scale demonstration of the technology for thirty years. Also, the molten salt cooled reactor is a technology that was first demonstrated in the 1960's.

CONCLUSION

Generation III or Generation III+ technologies can meet near term demand for new baseload electricity generation, and we are seeing signs that these technologies will be deployed in the U.S. in the near future. The Department of Energy's Energy Information Administration estimates the United States will need an additional 355,000 megawatts of electricity over the next two decades to meet the growing demand in this country, and nuclear energy will be needed to meet this demand. The U.S. and many other countries agree that Generation IV concepts must offer improved economics, proliferation resistance, reduced waste intensity, safety, and sustainability. In addition, these technologies need to be designed, developed, and demonstrated before 2030 in order to

support growing United States and global energy needs and also to help achieve our environmental objectives.

That concludes my testimony and I would be pleased to answer any questions you have.